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(54) Mixing machine.

(57) A mixer for mixing rubber or plastics compounds. The mixer has a casing (5), and two contra-rotating rotors supported in the casing with their axes of rotation parallel. Each rotor supports two nogs (6,7) of generally helical formation, one nog (6) comprising a single formation and the other (7) comprising two axially spaced formations between which the single formation nog of the other rotor is received as the rotors turn. To improve mixer throughput and efficiency, the radial distance between the radially outer surface of each nog of one rotor and the adjacent surface of the other rotor is substantially greater than the radial distance between the radially outer surface of each rotor nog and the inner surface of the casing, there is an axial gap between the trailing end of the single formation nog of each rotor and the adjacent axial end of the casing, whereby material being mixed can pass through the gap, the minimum gap between the trailing end of any one rotor nog and the leading end of another nog towards which it moves as the rotors turn is substantially greater than the gap between the radially outer surface of the nogs and the casing, and the sides of the nogs adjacent the chamber ends are streamlined to assist the flow of material across their surfaces.

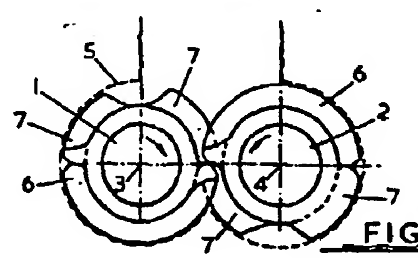

FIG. I

EP 0 170 397 A1

MIXING MACHINE

The present invention relates to a mixing machine.

Mixing machines are widely used in the rubber and plastics industries to mix together rubber and plastics compounds with appropriate additives such as dyes, plasticisers, cross-linking agents etc. Most mixers currently in use are in accordance with a basic design disclosed in U.S. Patent No. 2 015 618 dated 1935 and c mprise two rotors each supporting raised surfaces or n gs of spiral formation. Two nogs are provided on each rotor, one extending the full length of the rotor, the other being in two axially spaced sections to leave a gap therebetween to accommodate the full length nog f the other rotor. The rotors are mounted in a casing with their axes parallel and rotate in opposite directions. As each rotor turns its nogs sweep across the inside surface of the casing and extend between the nogs of the other rotor to a point adjacent the other rotor's surface. The compound to be mixed is subjected to a combined milling and kneading action as a result of the relative motion of the rotors and the casing surface. To avoid overheating of the compound being mixed the mixing machine is cooled by the circulation of water.

Mixers of the general type described in U.S. Patent N . 2 015 618 have been standard t the rubber and plastics industries for a long time and their

characteristics and design details are well known. It is accepted in the industry that the radial gap between the radially outer surface of each nog and the facing inner surface of the casing is a critical dimension of the machines, and typically this gap has been set at about 7 mm. It has also been accepted practice to endeavour to maintain a gap of the same magnitude between the radially outer surface of each nog and the facing surface of the other rotor, and between the trailing edge of the trailing end of the nog on one rotor and the adjacent leading edge of the nog on the other rotor. When rotors have been used for a prolonged period they become worn, and in particular the portion of the surface of each rotor which faces the radially outer surface of the nogs on the other rotor is worn away. As a result the gap between the nog and the rotor surface increases significantly. Although such rotor wear has been tolerated by some operators of mixing machines this is primarily due to the costs involved in replacing worn rotors. The performance of worn machines has been generally assumed to be suspect.

A further generally accepted feature of the known mixing machines has been the characteristics of the axial ends of the rotor nogs adjacent the axial end fac s of the mixer casing. Generally the l ading and trailing ends of each helical nog have extended to the

axial ends of the rotor so as to improve the cleaning ffect of the nog ends as they pass across the casing end wall. Furthermore the leading edge of the trailing end of the nogs has often been curved in the direction of rotation so as to improve the scraping effect of the nog on the end wall as shown in U.S. Patent No. 2 015 618. In addition the leading ends of the rotor n gs have been sharply contoured with a leading edge generally parallel to the rotor axis and a straight trailing edge with a view to achieving vigorous working of the compound being mixed and a good scraping ffect between the nog and the casing surfaces. Despite these design features it can be difficult to clean a mixer between mixing batches. This can be a very serious problem, particularly when the colour of successive batches is different, as even small amounts of material from one batch can seriously affect the quality of a subsequent batch.

It is an object of the present invention to obviate or mitigate the above problems.

According to the present invention, there is provided a mixer comprising a casing, two rotors supported in the casing with their axes of rotation parallel, and means for turning the rotors in opposite directions, each rotor supporting two nogs of generally helical formation, one nog comprising a single formation and th other comprising two axially spaced

formations between which the single formation nog of the other rotor is received as the rotors turn, wherein the radial distance between the radially outer surface of each nog of one rotor and the adjacent surface of the other rotor is substantially greater than the radial distance between the radially outer surface of each rotor nog and the inner surface of the casing.

The above arrangement enables the throughput of a machine in terms of weight per unit time to be increased as compared with conventional machines. More material can be mixed in one batch without increasing the mixing time.

Preferably the nog/rotor distance is greater than twice the nog/casing distance, e.g. 15 mm rather than 6.5 mm, although a 3 to 2 ratio or 7 to 4 ratio is also advantageous. The rotor diameter, excluding the raised nogs, may be uniform, but preferably depressions are formed in the rotor surface facing the nogs in the manner of "footprints" beneath the nogs. Preferably the edges of the depressions are smoothly contoured.

The invention also provides a mixer comprising a casing, two rotors supported in the casing with their axes of rotation parallel, and means for turning the rotors in opposite directions, each rotor supporting two nogs of generally helical formation, one nog

comprising a single formation and the other comprising two axially spaced formations between which the single formation nog of the other rotor is received as the rotors turn, wherein there is an axial gap between the trailing end of the single formation nog of each rotor and the adjacent axial end of the casing, whereby material being mixed can pass through the gap.

This arrangement improves the circulation of material and thus makes it easier to dump a batch of mixed material from the mixer and to clean the mixer thereafter, and hence makes it possible to effectively increase throughput. In addition however it appears that this arrangement also enables the volume of material in any one batch to be increased without any increase in mixing time or loss of quality which also of course enhances throughput.

The invention also provides a mixer comprising a casing, two rotors supported in the casing with their axes of rotation parallel, and means for turning the rotors in opposite directions, each rotor supporting two nogs of generally helical formation, one nog comprising a single formation and the other comprising two axially spaced formations between which the single formation nog of the other rotor is received as the rotors turn, wherein the minimum gap between the trailing end f any one rotor nog and the leading end of another nog towards which it moves as the rotors turn is substantially greater than the gap between the

radially outer surface of the nogs and the casing.

This arrangement again results in greater throughput.

The invention also provides a mixer comprising a casing, two rotors supported in the casing with their axes of rotation parallel, and means for turning the rotors in opposite directions, each rotor supporting two nogs of generally helical formation, one nog comprising a single formation and the other comprising two axially spaced formations between which the single formation nog of the other rotor is received as the rotors turn, wherein the sides of the nogs adjacent the chamber ends are stream-lined to assist the flow of material across their surfaces.

This arrangement makes it easier to dump mixed material from the mixer and to clean the mixer after the material has been dumped,

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which :

Figs. 1 and 2 illustrate features of the rotors of a conventional mixing machine; and

Figs. 3 and 4 illustrate the corresponding features of an embodiment of the present invention.

Referring to Fig. 1, this is an axial end view of two rotors 1 and 2 which are rotatable in the direction f the arrows about parallel axes 3 and 4 within a casing the walls of which are indicated by

dotted line 5. The casing is open at th top to allow material to be fed in, generally with the aid of a hydraulic ram, and a removable door (not shown) is provided in the casing centrally beneath the rotors to allow mixed material to be dumped from the machine. Each rotor supports two generally helical nogs 6 and 7, one formed by a single raised formation extending the full axial length of the rotor, and the other being formed by two axially spaced formations between which the nog 6 of the other rotor is received as the rotors turn.

Fig. 2 illustrates the rotor surface as it would appear if rolled out flat. It will be appreciated that the nog portions 7 define axially separated parts of a generally helical feature. Each helical nog extends axially the full length of the rotor and extends circumferentially just over half way around the rotor, the lines 8, 9, 10 and 11 being radially spaced by 90° from each other.

Referring now to Figs. 3 and 4, it will be seen that there are four significant differences between the rotor according to the present invention and the conventional rotor.

The first difference is that the shaded areas 12 are milled and ground away to define depressions which are located beneath the "footprints" of the nogs of th other rotor. Thus the minimum radial distance

between the radially outer surface of each nog and the surface of the other rotor is increased by the depth of the depression, e.g., from 6.5 mm to 15 mm. The dotted line in Fig. 3 shows the cross-section of one end of one of the depressions. It will be seen that the edges of the depression are streamlined.

The second difference is that the trailing end 13 of the long nog 6 is cut back so that there is an axial gap of for example 20 mm between it and the end of the rotor and hence the end wall of the casing (not shown).

The third difference is that the nip faces 14 at the adjacent ends of the nogs are ground back to increase the clearance between them, e.g. from 7 mm to 14 mm.

The fourth difference is that the portions 15 of the axial ends of the nogs are streamlined to improve the flow of material past them.

In a mixer of the type illustrated in Figs. 3 and 4 the throughput of material per batch (the batchweight) has been increased by 12 to 17% without any increase in mixing time or loss of quality as compared with a mixer of the type illustrated in Figs. 1 and 2 of the same basic dimensions, that is nog outer diameter 477 mm, rotor body diameter 349 mm, casing internal diameter 490 mm, rotor length 635 mm.

It is sometimes necessary however, to increase th rotor speed by up to 5% to maintain the same mixing

time as with a standard rotor. The power consumption per batch remains the same so that given a larger batch the specific power used (KWH/Kg) is reduced.

The invention has been described in terms of a complete mixing machine including the casing. It will be appreciated however that rotors modified in accordance with the invention may be supplied as replacements for conventional rotors in existing mixing machines rather than as components of complete mixing machines.

The use of local "footprints" or depressions in the rotor bodies to increase the gap between the nogs and the rotor bodies is described above. The whole of the rotor bodies could be of reduced diameter however to achieve the same effect. It is preferred however to use depressions as the cooled surface area of the rotor body is maintained which would not be the case if the whole rotor body was of reduced diameter. Furthermore, as the batch volume is largely determined by the ability of the rotors to take in or pass out material through the rotor nip rather than by the actual volume of the mixing chamber, the use of local depressions provides a greater area of contact between the mix material and the working surfaces of the rotors and mixing chamber by maintaining passageways for the material as shallow as possible.

To achieve adequate internal cooling cavities and

passages and to achieve maximum strength in bending at the rotor/shaft necks a two part shaft shrunk on rotor casting construction is generally used. The use of local "footprint" depressions avoids excessive loop stresses associated with a reduction in rotor diameter over its whole body. The stiffness resisting bending is also maintained.

The above described modification which results in a larger clearance between adjacent ends of the nogs increases the ability of the nogs to draw material into the mixer through the gap between the rotors and this causes an increase in the batch working volume.

The nog end nips form a barrier between the rotors which occurs every 180° of rotation and provides a kneading action which is essential to good mixing. If however the nog end nips are too tight then excessive compression of the mix material can occur and movement of the mix material within the mixing chamber is restricted. This causes increased power consumption and heat generation without contributing to useful mixing.

CLAIMS:

1. A mixer comprisng a casing, two rotors supported in the casing with their axes of rotation parallel, and means for turning the rotors in opposite directions, each rotor supporting two nogs of generally helical formation, one nog comprising a single formation and the other comprising two axially spaced formations between which the single formation nog of the other rotor is received as the rotors turn, wherein the radial distance between the radially outer surface of each nog of one rotor and the adjacent surface of the other rotor is substantially greater than the radial distance between the radially outer surface of each rotor nog and the inner surface of the casing, and/or there is an axial gap between the trailing end of the single formation nog of each rotor and the adjacent axial end of the casing, whereby material being mixed can pass through the gap, and/or the minimum gap between the trailing end of any one rotor nog and the leading end of another nog towards which it moves as the rotors turn is substantially greater than the gap between the radially outer surface of the nogs and the casing, and/or the sides of the nogs adjacent the chamber ends are stream-lined to assist the flow of material across their surfaces.

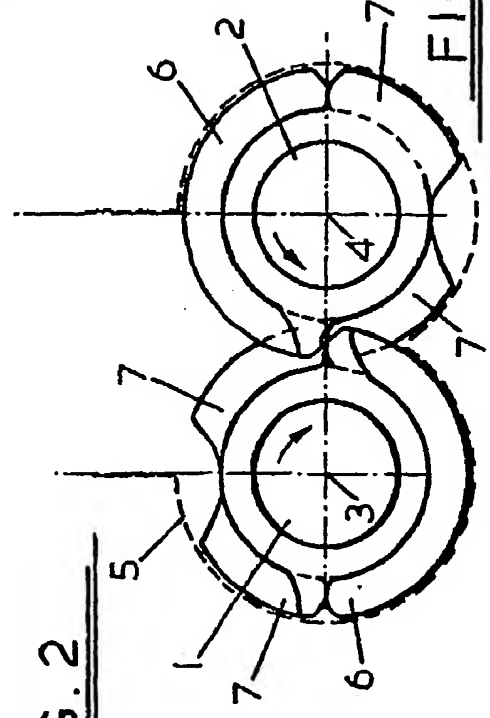

FIG. 1

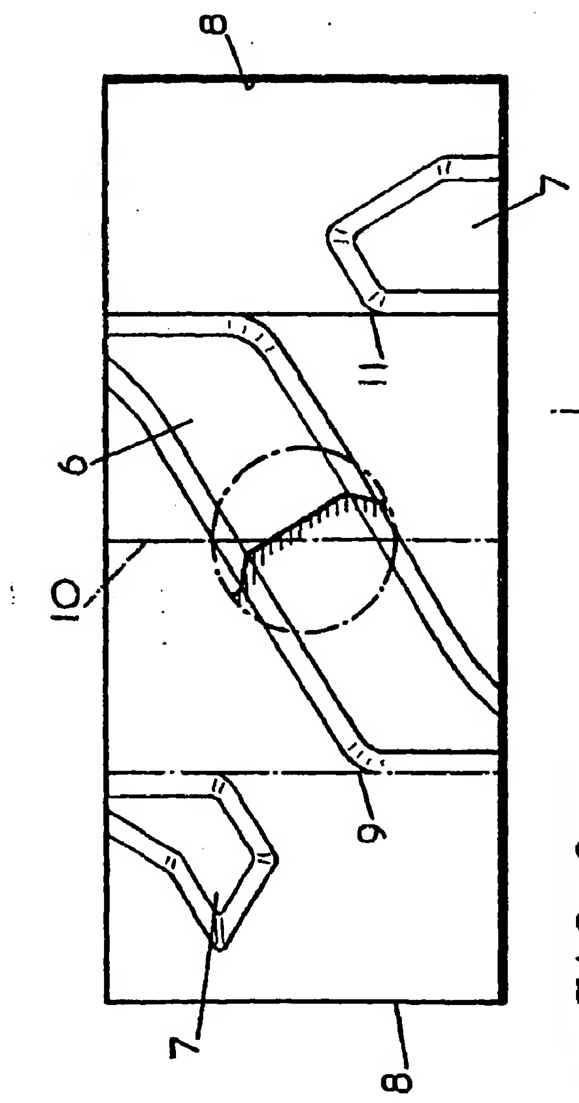

FIG. 2

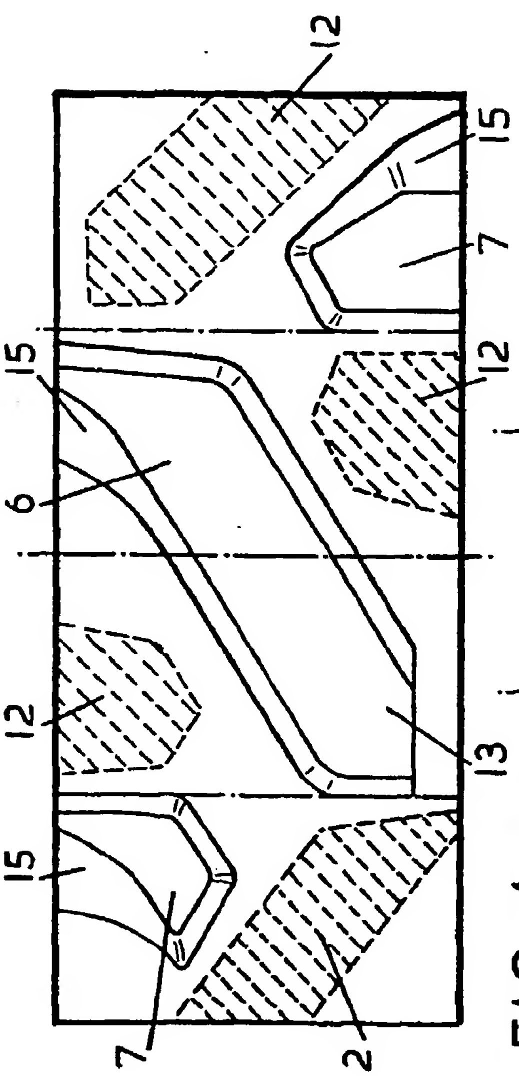

FIG. 4

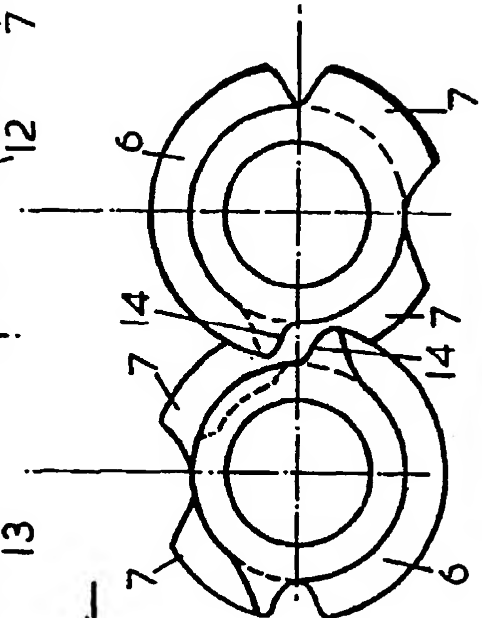

FIG. 3

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EUROPEAN SEARCH REPORT

0170397 Application number

EP 85 30 4547

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A,D	US-A-2 015 618 (COOKE) * Whole document *	1	B 29 B 7/18
A	JOURNAL OF THE INTERNATIONAL RUBBER INSTITUTE, vol. 4, no. 4, August 1970, pages 153-159; P. WHITAKER: "Modern mixing systems" * Page 153, section titled "The intermix"; figures 1,2 *	1	
A	GB-A-2 028 153 (WERNER & PFLEIDERER) * Page 4, lines 34-108; figures 8,9 *	1	
A	US-A-4 284 358 (SATO et al.)		TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	DE-A-1 454 771 (COMERICO ERCOLE)		B 29 B B 29 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20-09-1985	ASHLEY G.W.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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